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ACOUSTICAL PREFERENCE TUNER

CROSS-REFERENCE TO RELATED APPLICATIONS

This invention is related to Ser. No. 09/556,051, filed on April 21, 2000, which is continuation-in-part of application No. 09/340,518, filed on June 28, 1999, both pending, which in turn is a continuation-in-part of application No. 09/131,146, filed on August 7, 1998, now allowed, which in turn claims priority of provisional application No. 60/055,023, filed on August 8, 1997, the contents of which are hereby incorporated by reference.

FIELD OF THE INVENTION

This invention relates generally to audio communication networks, and more particularly, to an acoustical preference tuner in an audio communication network automatically selecting and delivering audio pieces to a user based on acoustical preference information.

BACKGROUND OF THE INVENTION

Radio stations broadcast audio pieces catered to the acoustical tastes of different types of listeners. A particular listener, however, may find it difficult to find an audio piece that he or she wants to hear when he or she wants to hear it. One reason for this is because the listener is tuned to one station when the desired audio piece is playing on a different station. Even if the listener is tuned to a correct radio station, the listener may tune-in too early or too late, and thus, miss the broadcast of the desired audio piece.

It is not uncommon, therefore, for users to continuously scan the various radio stations in hopes of finding an audio

piece that they would like to hear. The scanning of the radio stations, however, is cumbersome and does not guarantee that the user will find the desired audio piece.

Accordingly, there is a need in the current art for a system and method for creating a customized radio program including audio pieces that will cater to the listener's preferences. Such a system and method should analyze the acoustic characteristics of various audio pieces and select those pieces that are calculated to be to the listener's liking.

SUMMARY OF THE INVENTION

The present invention is directed to a system and method for creating a customized audio program in a communication network. According to one embodiment of the invention, a method for creating the customized audio program includes processing audio signals of an audio piece for compiling audio characteristic information including acoustic information associated with the audio piece. The method further includes receiving user audio preference information. The user audio preference information is compared with the audio characteristic information, and the audio piece is selected based on the comparison for including into the customized audio program.

According to another embodiment of the present invention, a method for creating the customized audio program includes receiving user audio preference information and audio characteristic information associated with a plurality of audio pieces, where the audio characteristic information includes acoustic information. The plurality of audio pieces are broadcast to a user station over one or more broadcast channels. The user audio preference information is compared with the audio

characteristic information, and a particular audio piece is identified based on the comparison. The particular audio piece is received over one of the broadcast channels, and stored in memory upon receipt.

In a further embodiment of the present invention, a method for creating the customized audio program includes receiving a plurality of audio pieces from one or more audio sources and storing the received plurality of audio pieces in a first database. The audio signals of an audio piece in the first database are processed for compiling audio characteristic information including acoustic information associated with the audio piece. The audio characteristic information is then stored in a second database. Upon receipt of user audio preference information, the user audio preference information is compared with the audio characteristic information and the audio piece is selected based on the comparison. The selected audio piece is transmitted to a user station over a computer network.

In an additional embodiment of the present invention, a system for creating the customized audio program includes a first processor processing audio signals of an audio piece for compiling audio characteristic information including acoustic information associated with the audio piece. The system further includes a first input for receiving user audio preference information, and a second processor coupled to the first input for comparing the user audio preference information with the audio characteristic information. The second processor selects the audio piece for including into the customized audio program based on the comparison.

In another embodiment of the present invention, a system for creating the customized audio program includes a first input for

receiving user audio preference information, and a second input for receiving audio characteristic information associated with an audio piece. The audio characteristic information preferably includes acoustic information. A processor coupled to the first input and the second input compares the user audio preference information with the audio characteristic information and selects a particular audio piece based on the comparison. The system further includes a tuner coupled to the processor for tuning to a channel carrying the audio piece, and a memory coupled to the processor and the tuner for storing the audio piece.

In a yet further embodiment of the present invention, a system for creating the customized audio program includes means for receiving a plurality of audio pieces, a first database coupled to the means for receiving for storing the received plurality of audio pieces, and a first processor processing audio signals of an audio piece in the first database for compiling audio characteristic information including acoustic information associated with the audio piece. The system further includes a second database coupled to the first processor for storing the audio characteristic information, an input for receiving user audio preference information, and a second processor coupled to the first database, the second database, and the input. The second processor compares the user audio preference information with the audio characteristic information and selects the audio piece based on the comparison. A network connection coupled to the second processor transmits the selected audio piece to a user station over a computer network.

DESCRIPTION OF THE DRAWINGS

These and other features, aspects and advantages of the present invention will be more fully understood when considered with respect to the following detailed description, appended claims, and accompanying drawings where:

FIG. 1 is a schematic block diagram of an audio communication network according to one embodiment of the invention;

FIG. 2 illustrates various audio pieces broadcast to a user station via multiple broadcast channels for creation of a customized audio program;

FIG. 3 is a more detailed block diagram of a user station configured to create a customized audio program according to the embodiment of FIG. 1;

FIG. 4 is a flow diagram of a process for selecting audio pieces to be included into a customized audio program according to one embodiment of the invention;

FIG. 5 is a flow diagram of a playback process of a customized audio program according to one embodiment of the invention;

FIG. 6 is a schematic block diagram of an audio communication network according to an alternative embodiment of the invention; and

FIG. 7 is a more detailed diagram of a network computer configured to create a customized audio program according to the alternative embodiment of FIG. 6.

DETAILED DESCRIPTION OF THE INVENTION

FIG. 1 is a schematic block diagram of an audio communication network according to one embodiment of the

invention. The audio communication network of FIG. 1 is preferably a multichannel communication network capable of delivering audio pieces via multiple broadcast channels.

The network includes a digital signal processor (DSP) 10 configured to process audio pieces 12 received from one or more audio sources 14. The audio pieces 12 preferably include music, voice, advertisements, or the like. The audio source 14 may be a CD, DVD, disk drive, external computer, or any other digital storage and/or communication device conventional in the art.

DSPs are well known to those skilled in the art. In general terms, the DSP 10 includes circuitry and logic for analyzing and quantifying audio characteristic information present in the audio pieces according to well-known methods. Such audio characteristic information preferably includes the audio piece's beat, tone, rhythm, tempo, and/or other acoustical characteristics. The audio characteristic information may also indicate the name of the performer, chart rank, release date, genre, and/or subject matter of the associated audio piece.

The network further includes a transmitter 16 for receiving the audio pieces 12 and a data stream 18 of the analyzed audio characteristics information from the DSP 10. The transmitter 16 selects all or portions of the audio pieces to communicate to a user station 20, preferably over multiple broadcast channels 22. The transmitter also transmits the audio characteristics information for the selected audio pieces, preferably over a separate data channel 24.

The transmitter 16 may be part of any multichannel broadcasting device conventional in the art, such as, for example, a radio or television broadcast station. The user station 20 may take the form of a radio, television, networked

device, personal digital assistant (PDA), personal RF device, or any other device capable of receiving the broadcast and data channels 22, 24.

The user station 20 preferably communicates with a user terminal 26 via wired or wireless media. The user enters his or her audio preference information into the user terminal 26 for communicating to the user station 20. Alternatively, the user enters the preference information directly into the user station 20 without the use of the user terminal 26.

According to the network illustrated in FIG. 1, the creation of the customized audio program is a post-transmission process where the user station 20 creates the customized audio program after receipt of the audio pieces transmitted by the transmitter 16. In this regard, the DSP 10 preferably creates an audio feature vector for each received audio piece including the audio characteristic information. Preferably, each field of the audio feature vector stores a value representing the extent of a particular audio characteristic present in the audio piece.

According to one embodiment of the invention, the audio pieces are analyzed and audio feature vectors created prior to the communication of the audio pieces to the user station 20. In an alternative embodiment, the analysis and creation of the audio feature vectors are done in real time with the communication of the audio pieces by the transmitter 16.

The transmitter 16 selects various audio pieces to be included in a broadcast program and communicates the selected audio pieces according to their broadcast time. The transmitter 16 also communicates the audio feature vectors associated with the selected audio pieces to the user station 20. Preferably,

the audio feature vectors are transmitted in the data channel 24 in advance of the broadcast of the associated audio pieces.

The user station 20 preferably receives the audio feature vectors prior to the receipt of the associated audio pieces. The user station 20 compares each audio feature vector against the audio preference information provided by the user to determine whether the associated audio piece should be included into the customized audio program.

In an alternative embodiment, the broadcast stations 20 transmit the audio feature vectors concurrently with the audio pieces in the broadcast channels 22. According to this alternative embodiment, each audio feature vector is communicated as header data preceding its associated audio piece. Analysis of the header data is then performed in real time by the user station 20 as the header data is received.

The creation of a customized audio program is discussed in general terms with respect to FIG. 2. FIG. 2 illustrates various audio pieces 65 broadcast to the user station 20 via the multiple broadcast channels 22. The audio pieces may include music pieces 65a, advertisements 65b, and the like.

Also illustrated in FIG. 2 are data packets 75 associated with the broadcast audio pieces 65. Each data packet preferably includes an audio feature vector 75a providing information about the audio characteristics of its associated audio piece. Each data packet also preferably includes a channel field 75b and a time field 75c identifying respectively a channel and time of the broadcast of the audio piece.

Preferably, the data packets 75 are transmitted to the user station 20 via the data channel 24 prior to the broadcast of the associated audio pieces. The transmission of the data packets

75 is preferably timed so as to allow the user station 20 sufficient time to process the packets and determine the audio pieces that are to be downloaded. As the user station 20 receives the data packets 75, it compares the audio feature vector 75a in each data packet with the user preference vector received from a particular user. The user station 20 then selects audio pieces 65c, 65d, 65e, 65f based on the comparison. The selected audio pieces preferably include audio characteristics that most closely resemble the user's preferences.

FIG. 3 is a more detailed block diagram of a user station 20 according to one embodiment of the invention. The user station 20 preferably includes a conventional tuner 30, preference tuner 32, input 34, sequencer 36, buffer 38, and output 40. The conventional tuner 30 is preferably a RF tuner 30 capable of tuning to the various broadcast channels 22 and the data channel 24.

The buffer 38 may be any memory or storage device conventional in the art, such as, for example, a FIFO buffer, receiving and temporarily storing certain audio pieces received via the broadcast channels 22. The buffer 38 may be of any given size that preferably determines the length of the customized audio program that may be scheduled at a time. Although the embodiment illustrated in FIG. 3 includes only one buffer, a person skilled in the art should recognize that the user station 20 may support multiple buffers, and is not limited to only one. In the case of multiple buffers, each buffer may be associated with a particular theme for downloading into the buffer audio pieces according to their themes. A particular theme may include dinner music, workout music, relaxation music, or the like.

The preference tuner 32 is preferably a software module accessed by an internal processor (not shown) programmed to select the audio pieces to be stored in the buffer based on the audio characteristic information received via the data channel 24 and user preference information received via the input 32. In an alternative embodiment, the system may be implemented by a combination of hardware, firmware, and/or software.

The input 34 includes but is not limited to a keyboard/keypad, program buttons/knobs, mouse, joystick, remote control unit, voice commands, IR/RF receiver, and/or data communication ports. The output allows playback of the downloaded audio pieces and/or display of prompts to the user. The output includes speakers, display screens/monitors, and/or other audio and/or visual output mechanisms. The sequencer 36 is preferably a software module controlling the downloading and playback of the audio pieces into and out of the buffer 38.

In general terms, a user communicates his or her audio preference information to the user station 20 preferably via the user terminal 26. In this scenario, the user terminal 26 preferably creates a user preference vector including the user's audio preference information and transmits the user preference vector to the user station 20. Alternatively, the user station creates the user preference vector from responses to questions posed by the user station 20 to the user about his or her audio preferences. The general process of obtaining user preference information and creating user preference vectors is discussed in further detail in the above-referenced U.S. application Ser. No. 09/556,051.

According to one embodiment of the invention the user station 20 creates or receives multiple user preference vectors

associated with particular themes. Each user preference vector is preferably associated with a theme that determines the type of audio pieces that are to be downloaded. For example, a user preference vector may be associated with a relaxation theme, dinner music theme, party theme, exercise theme, and the like.

The themes may be time varied. For instance, an exercise theme may cause the downloading of 5 minutes of slow music for warm-up followed by 20 minutes of high intensity music and 5 minutes of cool-down music. The user may provide a separate preference vector for the warm-up, high intensity, and/or cool-down portions. The user preference vectors may thus not only be associated with a particular theme, but also be associated with a time factor dictating when the user preference vector is to be used to select an audio piece within the theme.

The preference tuner 32 selects the appropriate user preference vector and compares it with the audio feature vector of each audio piece received by the user station 20. The preference tuner 32 selects the audio pieces that are to be included in the customized audio program based on the comparison. Preferably, the preference tuner 32 performs a minimum distance calculation of the user preference vector with each audio feature vector to select an audio piece that best caters to the user's preferences, as is described in further detail in the above-referenced U.S. Application Ser. No. 09/556,051.

The preference tuner 32 transmits to the sequencer 36 information about the selected audio pieces, including the associated broadcast channels and scheduled start times, for downloading the audio pieces into the buffer 38. The preference tuner 32 may also communicate to the sequencer 36 a new playback time for each audio piece to be downloaded.

The sequencer 36 preferably controls the downloading of the selected audio pieces into the buffer 38 as they are communicated via the broadcast channels 22 according to their scheduled broadcast times. The sequencer 36 further controls the playback of the downloaded audio pieces from the buffer 38. According to one embodiment of the invention, playback of the downloaded audio pieces occur upon powering-on of the user station 20. According to an alternative embodiment, playback of the downloaded audio pieces occur upon tuning to a particular broadcast channel. In another embodiment, playback occurs according to a customized audio program sequence set by the sequencer based on the customized playback times specified by the preference tuner 32. In any of the described embodiments, the earliest playback time for the audio piece is preferably no earlier than its earliest broadcast start time.

If the buffer is a FIFO buffer 38, the downloaded audio pieces are played on a first-in-first-out basis. Alternatively, the downloaded audio pieces are selected according to the customized audio program sequence. As the audio pieces are played, they are preferably removed from the buffer 38 and the buffer 38 is replenished with other audio pieces selected by the preference tuner 32. In an alternative embodiment, all or a portion of the played audio pieces is maintained in the buffer 38.

FIG. 4 is a flow diagram of a process for selecting audio pieces to be included into the customized audio program according to one embodiment of the invention. The process starts, and in step 80, the preference tuner 32 determines if all the data packets transmitted via the data channel 24 have been analyzed. If the answer is NO, the preference tuner 32 retrieves an audio

feature vector from a current data packet and calculates a vector distance between the audio feature vector and the user preference vector. In step 84, the preference tuner 32 determines if the calculated vector distance is less than a pre-determined threshold distance. Preferably, the threshold distance is selected based on the user's tolerance for audio pieces that deviate from his or her listening preferences. The threshold distance may also be selected based on the sparseness or density of the audio piece sampling space. In addition, the user may manually vary the threshold distance according to his or her preference.

If the calculated vector distance is less than the pre-determined threshold distance, the preference tuner 32 selects the audio piece associated with the analyzed audio feature vector as a potential download piece. The preference tuner 32 then proceeds to analyze the remaining data packets and calculates the vector distances for the audio feature vectors contained in those data packets.

If all the data packets have been examined, the preference tuner selects in step 88 the audio pieces associated with the smallest vector distance calculations as the audio pieces to be downloaded into the buffer 38. The number of audio pieces selected preferably depends on the buffer space available for downloading the audio pieces.

FIG. 5 is a flow diagram of a playback process of the audio pieces downloaded into the buffer 38 according to one embodiment of the invention. The process starts, and in step 90, the sequencer 36 determines if playback of the downloaded pieces has been triggered. For instance, the sequencer 36 may detect the powering-on of the user station 20, tuning to a particular

broadcast channel, and/or the start of a particular time period, as triggers for playback of the downloaded pieces. The sequencer 36 selects a particular audio piece from the buffer and plays the selected piece in step 92.

In step 94, the sequencer 36 determines whether the buffer segment associated with the played audio piece is to be freed. In this regard, the sequencer 36 determines if the user has indicated that the played audio piece be maintained in the buffer 38. If the user has made such an indication, the audio piece is not removed from the buffer 38. If the user has not indicated that the played audio piece be maintained in the buffer 38, the audio piece is removed from the buffer and the associated buffer segment is freed in step 96.

FIG. 6 is a schematic block diagram of an audio communication network according to an alternative embodiment of the invention. The network preferably includes a network computer 100 configured to analyze the audio characteristics of the audio pieces 102 received from one or more audio sources 104. The audio pieces 102 preferably include music, voice, advertisements, or the like. The audio source 104 may be a CD, DVD, disk drive, external computer, or any other digital storage and/or communication device conventional in the art.

The network computer 100 receives user audio preference information from a user station 112 and transmits a customized audio program to the user station 112 based on the information. Preferably, the communication between the network computer 100 and the user station 112 is over a wide area network 114, such as the internet, using conventional telephone lines, ISDN lines, coax cable, fibre optics, satellite, or the like. The user station 112 may take the form of a personal computer, PDA, set-

top box, personal RF device, or any other device conventional in the art capable of networked communication with the network computer 100.

The network computer 100 preferably hosts an audio program database 106, audio feature database 108, and a user preference database 110. These databases preferably reside in one or more mass storage devices taking the form of a hard disk drive or drive array. The audio program database 106 preferably stores the audio pieces 102 received from the audio source 104. The audio feature database 108 stores the audio characteristic information of each audio piece preferably as an audio feature vector. The user preference database 110 stores the user audio preference information received from the user station 112 preferably as one or more user preference vectors.

According to the network illustrated in FIG. 6, the creation of the customized audio program is a pre-transmission process where the network computer 100 creates the customized audio program prior to the transmission of the audio pieces to the user station 112. In this regard, the network computer 100 preferably creates an audio feature vector for each received audio piece including the audio characteristic information. Preferably, each field of the audio feature vector stores a value representing the extent of a particular audio characteristic present in the audio piece. The audio characteristic may include acoustic information such as, for example, beat, tone, rhythm, and/or tempo present in the audio piece. The audio characteristic information may also indicate the name of the performer, chart rank, release date, genre, subject matter, and/or the like.

The network computer 100 further creates one or more user preference vectors from the user audio preference information received from the user station 112. Each field of the user preference vector preferably stores a value representing the user's preference for a particular audio characteristic. Separate user preference vectors may be created and associated with particular themes, such as, for example, an exercise theme, a dinner music theme, a relaxation theme, and the like.

The network computer 100 compares the user preference vector from the user preference database 110 with one or more audio feature vectors in the audio feature database 108 and selects one or more audio pieces that are catered to the user's preferences. The network computer 100 then transmits the selected audio pieces to the user station 112 over the wide area network 114.

FIG. 7 is a more detailed diagram of the network computer 100 according to one embodiment of the invention. The network computer 100 preferably includes a DSP 120 which may be similar to the DSP 10 of FIG. 1 including circuitry and logic for analyzing and quantifying audio characteristic information present in the audio pieces received from the audio source 104.

The network computer 100 further includes a preference tuner 122, sequencer 124, and buffer 126 which may be similar to the preference tuner 32, sequencer 36 and buffer of FIG. 3. The preference tuner 122 is preferably a software module accessed by an internal processor (not shown) programmed to select the audio pieces stored in the audio program database 106 based on the audio characteristic information stored in the audio feature database 108 and the user preference information stored in the user preference database 110. The sequencer 124 is preferably

a software module controlling the downloading and playback of the audio pieces into and out of the buffer 126. The buffer 126 may be any memory or storage device conventional in the art, such as for example, a FIFO buffer, receiving and temporarily storing audio pieces retrieved from the audio program database 106. Although the embodiment illustrated in FIG. 7 includes only one buffer, a person skilled in the art should recognize that the network computer 100 may support multiple buffers, and is not limited to only one.

In general terms, the DSP 120 preferably creates an audio feature vector including the audio characteristic information for each audio piece received from the audio source 104. Preferably, each field of the audio feature vector stores a value representing the extent of a particular audio characteristic present in the audio piece. The audio feature vectors are then stored in the audio feature database 108. The audio pieces are also stored in the audio program database 106.

In creating a customized audio program, the preference tuner 122 retrieves a user preference vector from the user preference database 110 and compares the user preference vector with the audio feature vectors in the audio feature database 108. According to one embodiment of the invention, the user preference vector is retrieved based on a theme selected by the user. The indication of the theme selection is preferably transmitted to the network computer 100 over the wide area network.

The compared audio feature vectors preferably correspond to the audio pieces in the audio program database 106 that are eligible for selection. According to one embodiment of the invention all of the audio pieces in the audio program database 210 are eligible to be included into the customized audio

program. In another embodiment of the invention, the selection is limited to a subset of the audio program database 106. In accordance with this latter embodiment, the preference tuner 122 maintains track (e.g. in a cache) of the audio pieces selected for other users according to their preference information, and chooses among these audio pieces to create the customized audio program. Alternatively, multiple hypothetical audio program sequences may be created for emulating multiple broadcast channels broadcasting multiple audio programs, and selection may be limited to the audio pieces in the hypothetical audio programs.

Preferably the preference tuner 122 performs a minimum distance calculation of the user preference vector with all or a subset of the audio feature vectors to select an audio piece that best caters to the user's preferences, as is described in further detail in the above-referenced U.S. Application Ser. No. 09/556,051. The preference tuner 122 transmits information about the selected audio pieces to the sequencer 124. The sequencer 124 uses the information to create the customized audio program for the user. In this regard, the sequencer 124 retrieves the selected audio pieces from the audio program database 106 and preferably stores them in the buffer 126 for transmitting to the requesting user station 112. The sequencer 124 may also assign a customized program sequence to the audio pieces for future playback. In an alternative embodiment, the selected audio pieces are not stored in the buffer 126, but are transmitted to the requesting user station 112 as soon as they are selected by the preference tuner 122.

Although this invention has been described in certain specific embodiments, those skilled in the art will have no

difficulty devising variations which in no way depart from the scope and spirit of the present invention. It is therefore to be understood that this invention may be practiced otherwise than is specifically described. Thus, the present embodiments of the invention should be considered in all respects as illustrative and not restrictive, the scope of the invention to be indicated by the appended claims and their equivalents rather than the foregoing description.